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H05B 3/10 3/24

(52) UK CL (Edition Q)
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U1S S2400

(56) Documents Cited
GB 2319943 A **GB 2136549 A** **GB 0884826 A**
US 5498853 A **US 4410564 A**

(58) Field of Search
UK CL (Edition P) **H5H HAA3 HAA6 HAA9 HBB1 HBB2 HBE1 HBE2 HBG1 HBG2 HCA**
INT CL^6 **H05B 3/10 3/20 3/22 3/24 3/30 3/40 3/42 3/74**
Online: WPI, JAPIO, CLAIMS

(54) Abstract Title
Infra-red heaters and elements therefor

(57) A heating element for an infra-red heater is made from an elongate strip 1 of sheet metal such as nickel chrome. The strip 1 has a varying cross-sectional area along its length, in order to provide an electrically resistive heating effect which varies along the length of the element. The area may be varied by having a non-uniform width of thickness, or by providing apertures (7, see figure 7) along the strip. The heater may be used to heat articles positioned on a conveyor belt 14.

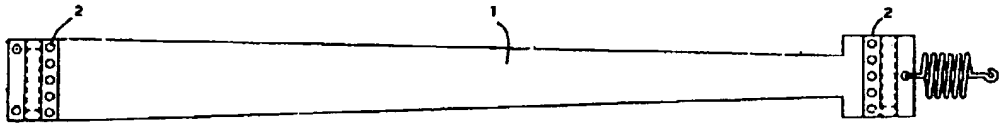

Fig 3

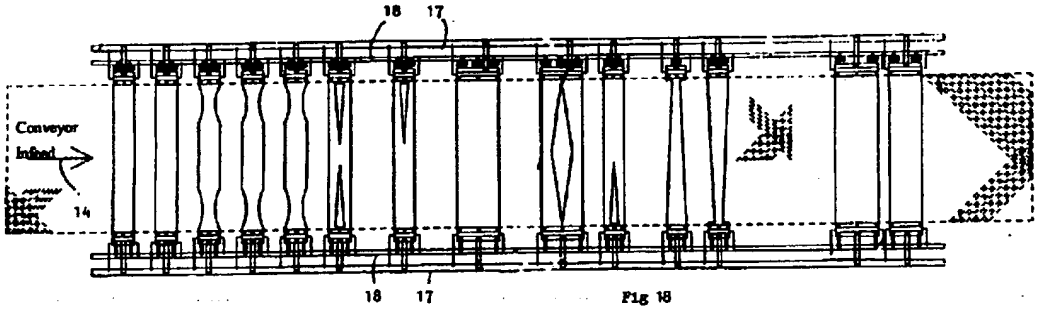

Fig 18

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The claims were filed later than the filing date within the period prescribed by Rule 25(1) of the Patents Rules 1995

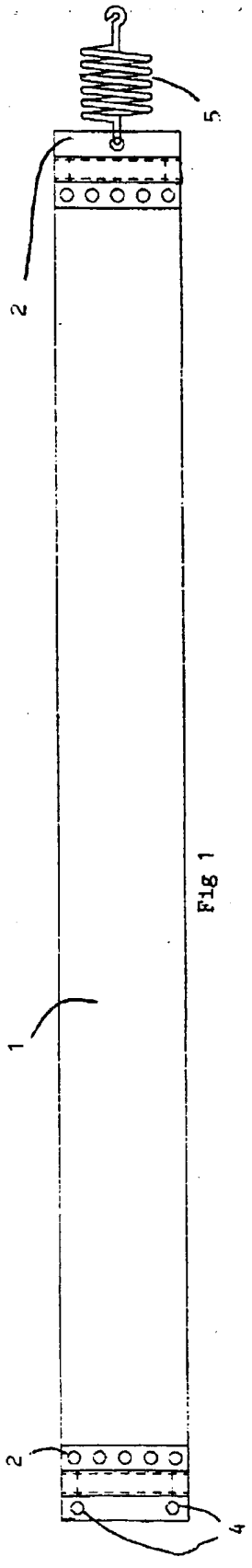


Fig 1

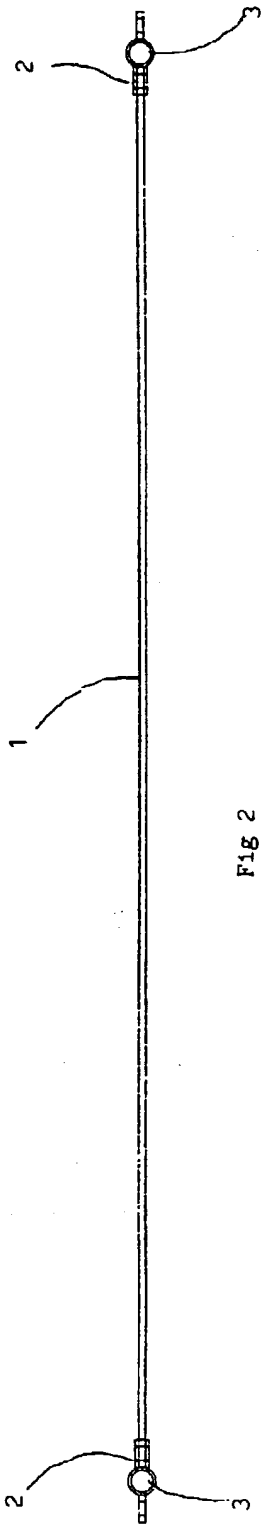


Fig 2

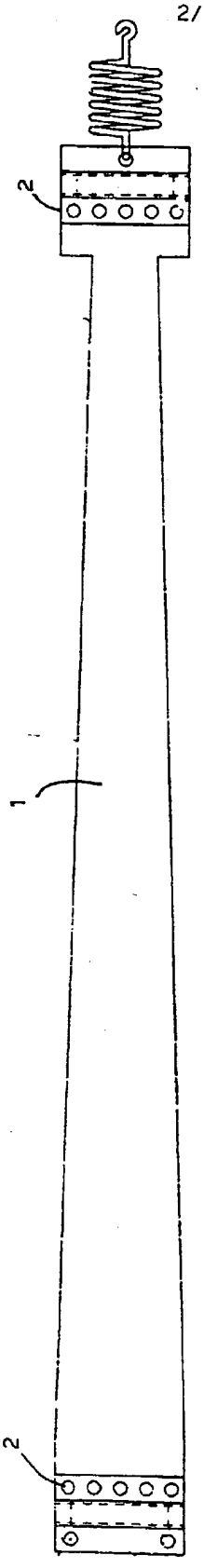


Fig 3

Fig 4

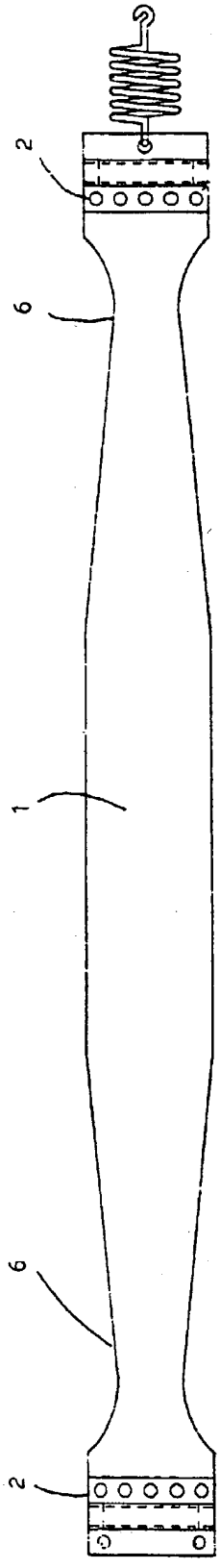


Fig 5

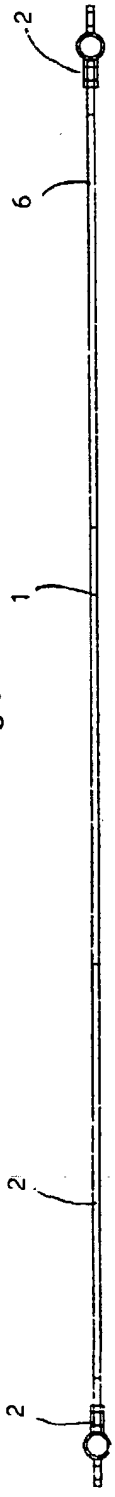


Fig 6

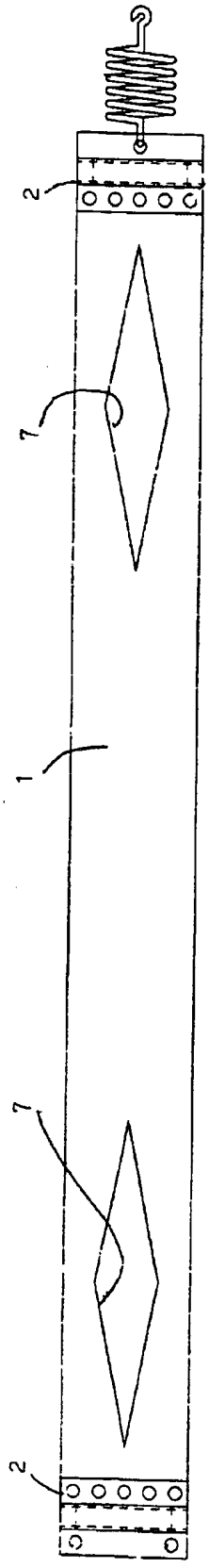


Fig 7

Fig 8

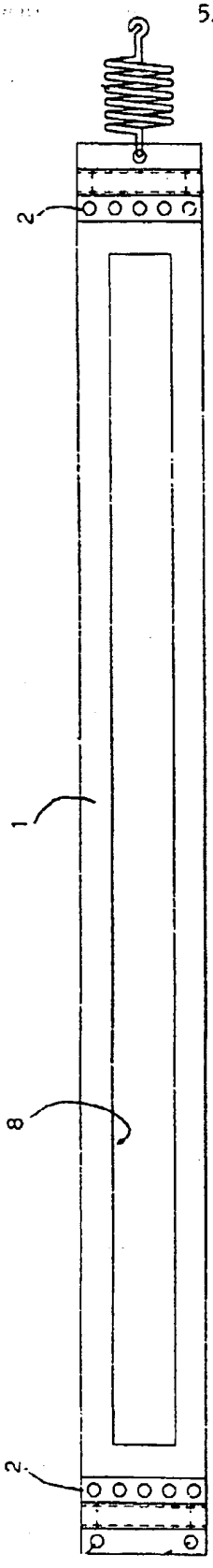


Fig 9

Fig 10

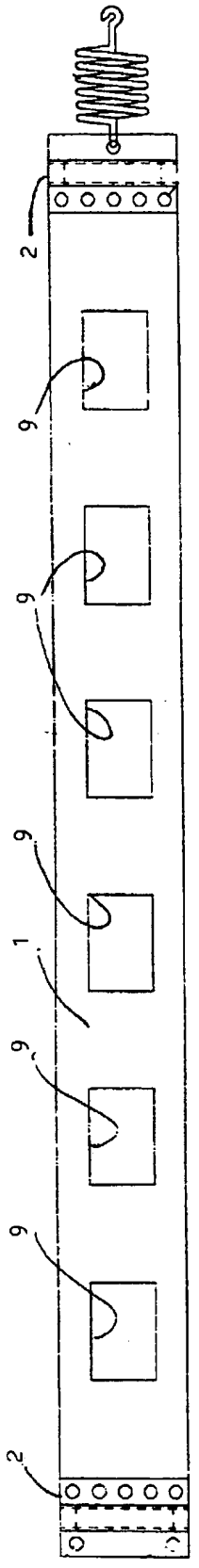


Fig 11

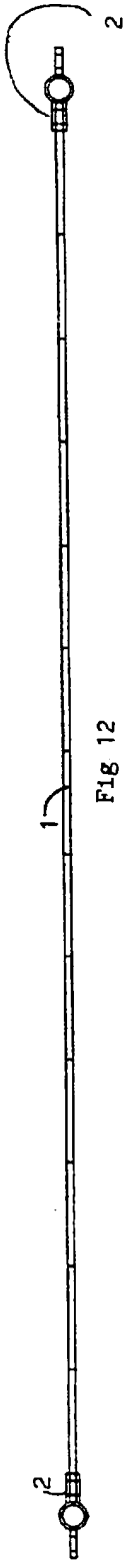


Fig 12

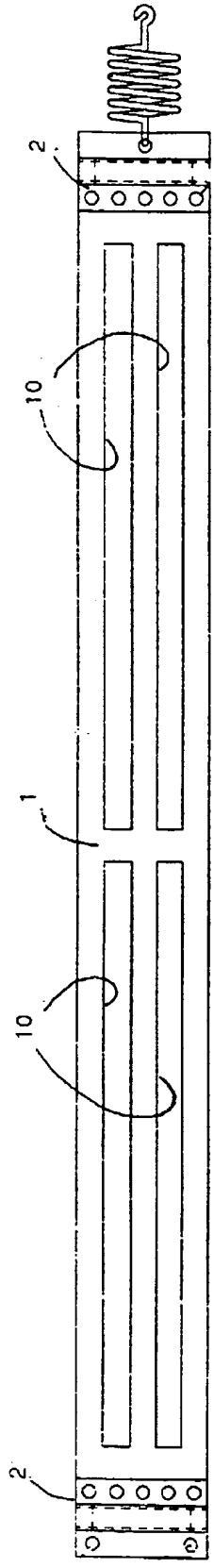


Fig 13

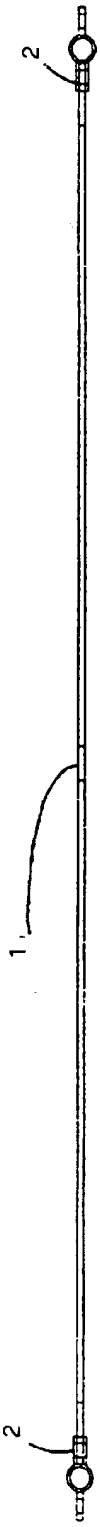


Fig 14

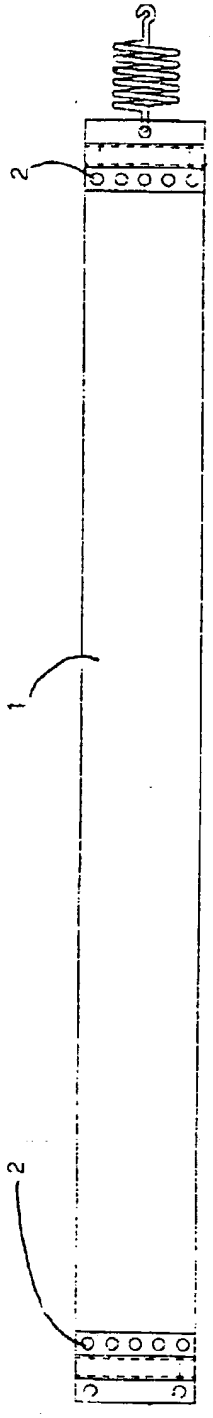


Fig 15

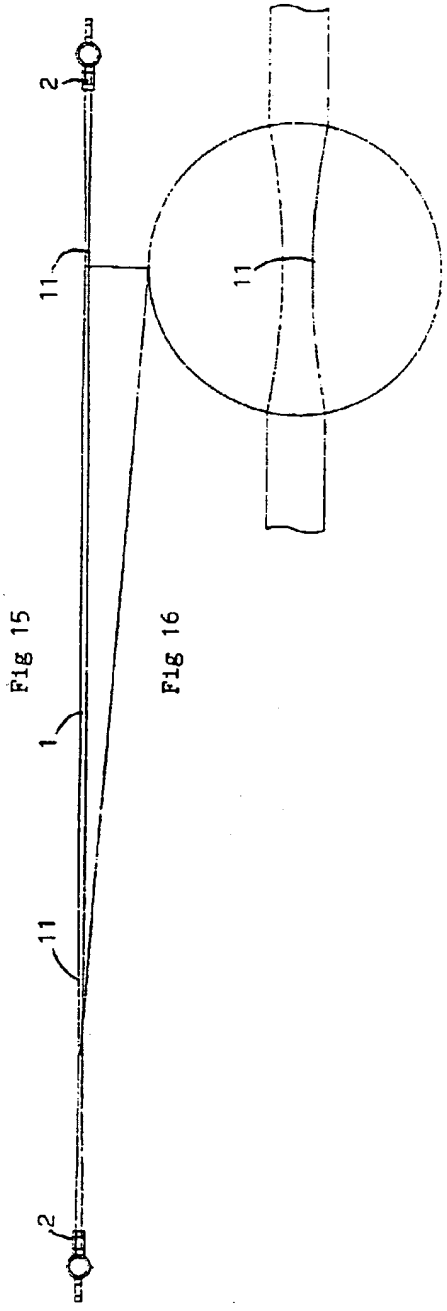


Fig 16

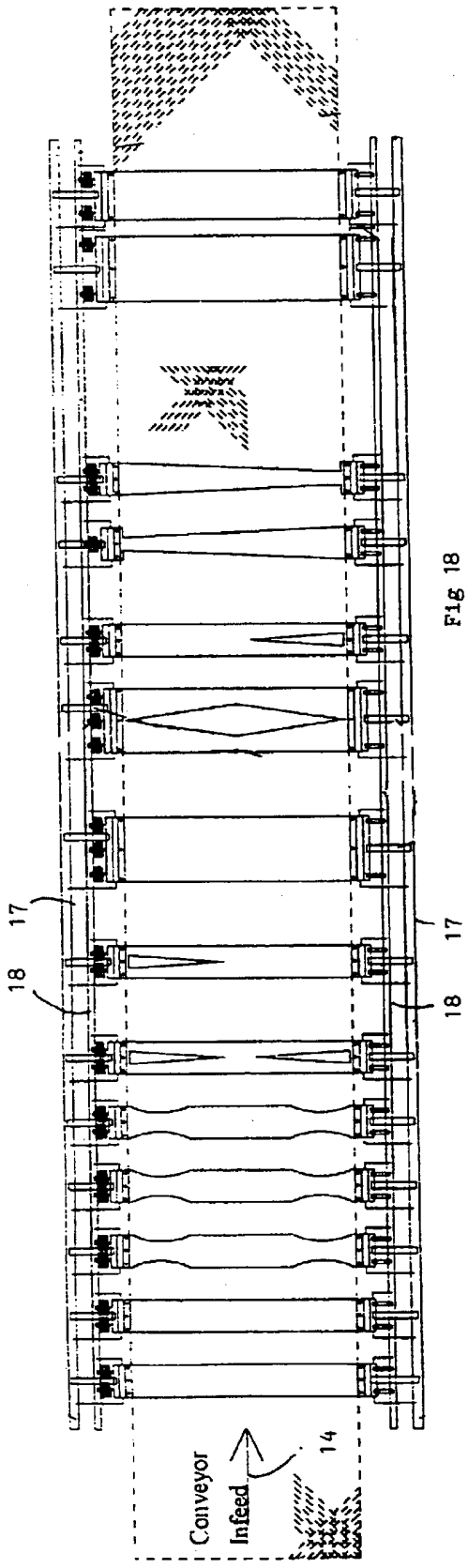


Fig 18

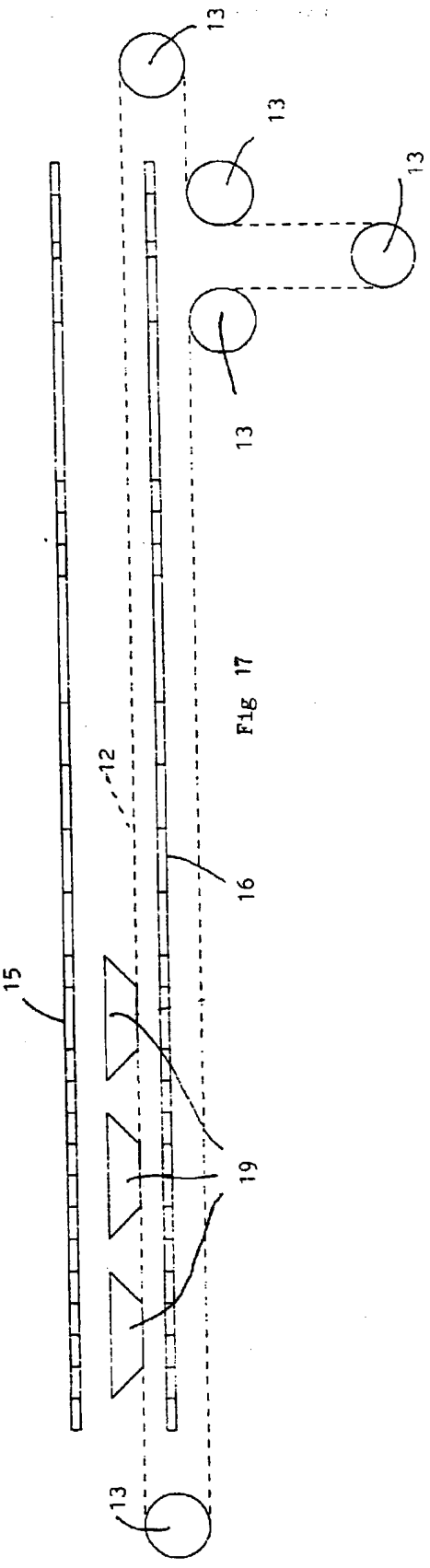
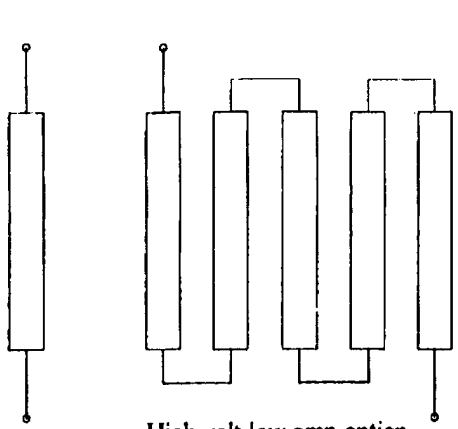
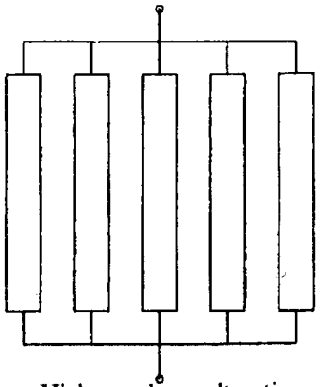


Fig 17

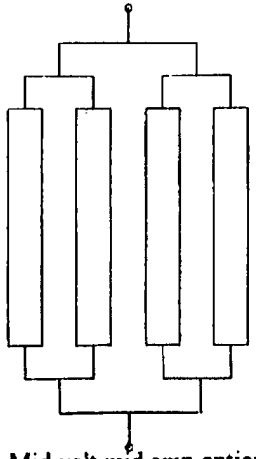


Single heater option

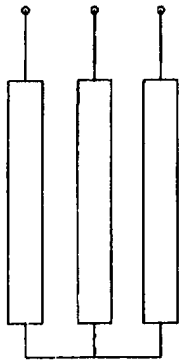
High volt low amp option



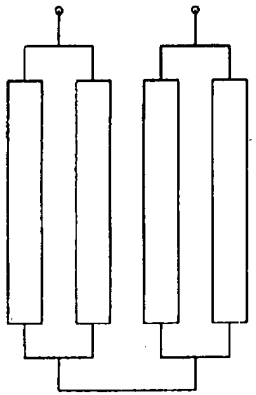
High amp low volt option



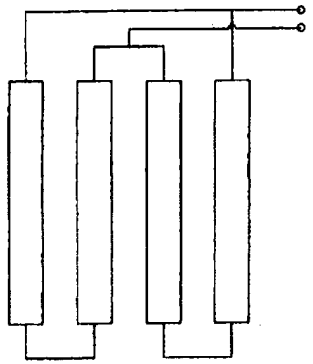
Mid volt mid amp option



3 phase option



Series parallel option



Series Parallel option

Heater connection options for single and three phase circuits

Figure 19

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TITLE: INFRA-RED HEATERS AND ELEMENTS THEREFOR

This invention relates to infra-red heaters and to elements (sometimes called emitters) therefor. Such elements produce radiant heat as a result of the resistive heating effect of an electric current passing through the element.

According to one aspect of the invention there is provided an electrically energisable heating element for an infra-red heater, the heating element being of metal and of elongated form, the element having a varying cross-sectional area chosen to impart a desired heating effect along the element. The element may be generally tubular or cylindrical, formed (eg by machining) with a non-uniform cross-sectional area along its length.

According to another aspect of the invention there is provided an electrically energisable heating element for an infra-red heater, the heating element comprising an elongated strip of sheet metal having, along its length, a constant or varying cross-sectional area chosen to impart a desired heating effect along the length of the element.

The strip of sheet material may be nickel chrome alloy strip and the ends of the strip preferably have copper mounting brackets for mounting the element in the infra-red heater, eg by bolting or friction welding. The mounting brackets may have through passages for the passage of cooling fluid (eg water) to cool the mounted ends of the element in use.

In preferred embodiments, the cross-sectional area varies along the length of the element, the smaller the cross-sectional area the greater the resistive heating effect and therefore the greater the local temperature of the element and the shorter the wavelength of the infra-red radiation emitted by the element.

Preferably, the thickness of the element is constant, its width being varied in order to

provide the desired variation in cross-sectional area. The effective width may be varied by shaping one or both longitudinal edges, by incorporating apertures in the strip or by both of these expedients. The longitudinal edges may be joggled, eg to form a sinuous shape, to increase strength and focus radiant energy in required directions.

As an alternative, or in addition, to varying the width of the element, the thickness of the element may be varied.

According to a yet further aspect of the invention there is provided an infra-red heater comprising a plurality of electrically energisable heating elements each having an elongated strip of sheet metal having, along its length, a constant or varying cross-sectional area to impart the desired heating effect along the length of the element.

The elements may be arranged in any grouping to suit the required overall heating effect, but a preferred arrangement is for the elements to be mounted in spaced parallel relationship. For example, in the application of the invention to a heater in the form of an infra-red oven (or grill), the elements are positioned in spaced parallel relationship above a conveyor which is guided for movement in a direction transverse to the direction of elongation of the elements, the conveyor being suitable for conveying beneath the array of elements items to be heated such as food items to be cooked, grilled or browned or non food items to be heat treated. The array of elements above the conveyor may be supplemented by a further array of elements positioned below the conveyor, depending on the required direction of application of radiant heat to the items to be treated. It will be appreciated that the heating elements may be positioned to one or both sides of the item to be heat treated, and that the heating elements may be shaped and positioned to treat curved or specially shaped items.

The invention solves the problem of a reduced heating effect at the conveyor edges, because by reducing the cross-sectional area of certain (or all) of the heating elements at regions adjacent their ends, the radiant heating effect at these regions is increased. It will be appreciated that, in general, each element can have a particular variation of cross-sectional area along its length to impart any desired heating variation along the width or

along the length of the conveyor.

The elements are preferably detachably mounted in the heater, eg by fixing bolts and tensioning means such as tension springs, weights, hydraulic cylinders or gas springs, so that individual elements can be changed or replaced easily and quickly, enabling the power density distribution both across and along the conveyor to be readily modified to suit particular items to be treated.

The invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figures 1 and 2 are plan and edge views respectively of a first embodiment of heating element,

Figures 3 to 16 are similar views of second to eighth embodiments of heating element,

Figure 17 is a side elevation of an oven conveyor including heating elements according to the invention,

Figure 18 is a plan view of the oven conveyor of Figure 17, and

Figure 19 shows various possibilities for connecting the heating elements in parallel, series or series/parallel arrangements.

The heating element illustrated in Figure 1 is made of an elongate strip 1 of nickel chrome alloy of constant width (as shown in Figure 1) and constant thickness (as shown in Figure 2). At each end, a copper mounting bracket 2 is bolted to the strip. Each mounting bracket has a through bore 3 for the passage of cooling fluid. One mounting bracket, that shown at the right hand end of Figures 1 and 2, has an outer flange with spaced holes 4 for attaching this end of the element in a heater. The other bracket has an end flange with a single hole to receive a tension spring 5 for mounting this end of the element in the

heater. The end flange may have a plurality of holes receiving the ends of a corresponding plurality of tension springs arranged in parallel.

In Figures 3 to 16 similar parts to those in Figures 1 and 2 are given the same reference numerals. Strip 1 of the element of Figures 3 and 4 is of constant thickness but its width tapers uniformly from one end of the heating element to the other, by virtue of the longitudinal edges of the strip 1 converging in a direction progressing from left to right in Figures 1 and 2. As a result, the cross-sectional area of the strip varies linearly from one end to the other, the end having the smaller cross-sectional area producing a greater radiant heating effect and therefore producing infra-red radiation of a higher frequency.

The strip 1 of the element of Figures 5 and 6 is again of uniform thickness but it is of varying width as illustrated in Figure 5. The width varies so that the strip has end regions 6 which are waisted in order to increase the heating effect at these regions near the ends of the heating element.

A similar effect is achieved by the element shown in Figures 7 and 8, where adjacent each end of the strip 1 a diamond shaped aperture 7 is provided in order to decrease the effective cross-sectional area of the strip 1 in these regions.

The strip 1 of the element of Figures 9 and 10 has formed therein an elongated rectangular aperture 8 which extends for the complete length of the strip, save for a small length at each end thereof.

In the element of Figures 11 and 12 the strip 1 has a series of longitudinally spaced apertures 9, imparting to the strip a cross-sectional area which progressively increases and decreases in a stepwise fashion along the length of the strip.

A further variation of apertures is shown in the element of Figures 13 and 14 where the strip 1 has four symmetrically arranged apertures 10, with each aperture 10 being of rectangular elongated shape and extending for rather less than half the length of the heating element.

The strip of Figures 15 and 16 is of constant width but its thickness varies along its length. In particular, the thickness is reduced over two longitudinally spaced regions 11, those reduced-thickness regions 11 being shown in the enlarged scale part of Figure 16.

Figures 17 and 18 show a heater having an endless conveyor 12 guided for movement by rollers 13 in a direction shown by arrow 14 in Figure 18. An upper horizontal run of the conveyor path passes between an upper array 15 of heating elements and a lower array 16 of heating elements. Each element of the upper and lower array extends transversely to the direction of movement of the upper horizontal run of the conveyor. The elements of the upper array 15 occupy a common horizontal plane and the elements 16 of the lower array similarly occupy a common horizontal plane. The elements may instead be staggered vertically, or occupy a common plane inclined to the upper horizontal run of the conveyor.

As shown in Figure 18, the heater has along each side a water cooled copper bus bar 17 which, by means of individual heater connections, feeds electrical power to the heating elements of the arrays 15 and 16. The bus bars 17 are powered by a transformer supply at a voltage of somewhat less than 50 volts at a current of 1000 A and at a frequency of 50 Hz. Pipes 18 along respective sides of the heater supply cooling water to the cooling passages at each end of each heating element The elements may be connected in groups in parallel, such groups then being connected in series. The elements may also be connected in series. Various connection possibilities are illustrated in Figure 19.

Products to be heated, shown diagrammatically at 19 in Figure 17, are delivered to the infeed end of the conveyor 12, pass between the upper and lower heater arrays 15, 16 and are removed from the conveyor at the outfeed end.

Each of the heating elements shown in Figures 17 and 18 may be of the form shown in Figures 1 to 16, or any other chosen shape for imparting a required power density to the horizontal run of the conveyor. The heating element shapes may differ along the length of the conveyor and may differ between the upper array 15 and the lower array 16, dependent on the required heating effect required. It is expected that a heating element

having the shape of Figures 5 and 6 (or Figures 15 and 16) will be particularly beneficial for use in an oven conveyor because the waisted regions at each end of the element overcome the problem of undue cooling at the conveyor edges.

The product to be heat treated may be supplied to the conveyor in spaced lanes, with the shaping of the heating elements being chosen to suit, or the products may be fed onto the conveyor so that they crowd onto the conveyor and do not form predetermined lanes of movement.

The electrical supply to the oven may be a.c. or d.c and at any voltage or current, but a maximum voltage of about 50 volts has the advantage of safety. Further advantages of the described oven are that it is robust and safe for the food industry, without the use of glass or quartz.

The inventive element offers a wide spectrum of infra-red emissions, both long wave and medium wave from a single emitter element.

CLAIMS

1. An electrically energisable heating element for an infra-red heater, the heating element being of metal and of elongated form, the element having a varying cross-sectional area chosen to impart a desired heating effect along the element.

2. A heating element according to claim 1, wherein the element is generally tubular or cylindrical, with a non-uniform cross-sectional area along its length.

3. An electrically energisable heating element for an infra-red heater, the heating element comprising an elongated strip of sheet metal having, along its length, a constant or varying cross-sectional area chosen to impart a desired heating effect along the length of the element.

4. A heating element according to claim 3, wherein the strip of sheet metal is nickel chrome alloy strip.

5. A heating element according to claim 4, wherein the ends of the strip have copper mounting brackets for mounting the element in the infra-red heater.

6. A heating element according to claim 5, wherein the mounting brackets have through passages for the passage of cooling fluid to cool the mounted ends of the element in use.

7. A heating element according to any of claims 3 to 6, wherein the thickness of the strip is constant, its width being varied along its length in order to provide the desired variation in cross-sectional area.

8. A heating element according to claim 7, wherein the effective width of the strip is varied by shaping one or both longitudinal edges of the strip.

9. A heating element according to claim 7, wherein the effective width of the strip is

varied by incorporating apertures in the strip.

10. A heating element according to any of claims 3 to 6, wherein the thickness of the strip is varied to vary the effective width.

11. An infra-red heater comprising a plurality of electrically energisable heating elements each having an elongated strip of sheet metal having, along its length a constant or varying cross-sectional area to impart a desired heating effect along the length of the element.

12. An infra-red heater according to claim 11, wherein the elements are mounted in spaced parallel relationship.

13. An infra-red heater according to claim 12, wherein the elements are positioned in spaced parallel relationship above a conveyor which is guided for movement in a direction transverse to the direction of elongation of the elements, the conveyor being suitable for conveying beneath the array of elements items to be heated such as food items to be cooked, grilled or browned or non food items to be heat treated.

14. An infra-red heater according to claim 13, wherein the array of elements above the conveyor is supplemented by a further array of elements positioned below the conveyor.

15. An infra-red heater according to claim 13 or 14, wherein the elements are detachably mounted in the heater, so that individual elements can be changed or replaced, enabling the power density distribution both across and along the conveyor to be readily modified to suit particular items to be treated.

16. An infra-red heater constructed and arranged substantially as herein particularly described with reference to any one of the alternative embodiments illustrated in the accompanying drawings.

The Patent Office

9

Application No: GB 9727492.2 **Examiner:** Peter Emerson
Claims searched: 1-16 **Date of search:** 14 October 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): H5H HAA3, HAA6, HAA9, HCA, HBB1, HBB2, HBE1, HBE2, HBG1, HBG2

Int Cl (Ed.6): H05B 3/10, 3/20, 3/22, 3/24, 3/30, 3/40, 3/42, 3/74

Other: Online: WPI, JAPIO, CLAIMS

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB 2319943 A	(EUROCOPTER) - figures 3-9.	
A	GB 2136549 A	(IMPACT)	13
X	GB 884826 A	(CAV) - fig. 3.	1, 3, 7
X	US 5498853 A	(EGO) - col 11, para 6 - col 12 para 2, col 13 para 3, figs 1, 5-11.	1, 3, 7-9, 11, 12
X	US 4410564 A	(RAIVI) - col 3 para 5 - col 4 para 5, figs 5, 7-9.	1, 3, 7, 10-12

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.